REVISED UNIVERSAL

SOIL LOSS EQUATION

(RUSLE)

NATURAL RESOURCES CONSERVATION SERVICE

OKLAHOMA

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INTRODUCTION

This handbook contains guidelines and procedures for using the Revised Universal Soil Loss Equation (RUSLE) in Oklahoma. The primary intended users are the Natural Resources Conservation Service (NRCS) and their conservation partners in Oklahoma. The Soil and Water Conservation Society (SWCS) has certified NRCS databases. The data used in this handbook is not to be altered or amended unless it is first submitted for SWCS certification.

The RUSLE is an improved automated version of the original USLE technology that has been used for erosion prediction since 1965. The equation remains the same as USLE which is:

$$A = R * K * L * S * C * P$$

where

> **A = computed spatial average soil loss and temporal average soil loss per unit of area, expressed in the units selected for K and for the period selected for R. In practice, these are usually selected so that A is expressed in tons/acre/year.**
>
> **R = rainfall-runoff erosivity factor -- the rainfall index plus erosion index plus a factor for any significant runoff from snowmelt.**
>
> **K = soil erodibility factor -- the soil rate per erosion index unit for a specified soil as measured on a standard plot, which is defined as a 72.6 ft. (22.1 m.) length of uniform 9% slope in continuous clean-tilled fallow.**
>
> **L = slope length factor -- the ratio of soil loss from the field slope length to soil loss from a 72.6 ft. length under identical conditions.**
>
> **S = slope steepness factor -- the ratio of soil loss from the field slope gradient to soil loss from a 9% slope under otherwise identical conditions.**
>
> **C = cover-management factor -- the ratio of soil loss from an area with specified cover and management to soil loss from an identical area in tilled continuous fallow.**
>
> **P = support practice factor -- the ratio of soil loss with a support practice like contouring, stripcropping, or terracing to soil loss with straight-row farming up and down slope.**

RUSLE is an erosion model designed to predict the longtime average soil loss “A” carried by runoff from specific field slopes in specified cropping and management systems as well as from rangeland. Widespread use has substantiated the usefulness and validity of RUSLE for this purpose. It is also applicable to nonagricultural conditions such as construction sites.

RUSLE users need to be aware that "A" (in addition to being a longtime average annual soil loss) is the average loss over a field and that the losses at various parts of the field may differ greatly from one another. On a long uniform slope, the loss from the top part of the slope is much lower than the slope average, and the loss near the bottom of the slope is considerably higher. For instance, a 360 ft. uniform slope that averages 20 tons per acre will have an average of less than 7 tons per acres loss on the first 40 ft. but over 29 tons per acre loss on the last 40 ft. If the slope steepness changes within that length, the variation can be even greater. This suggests that even if a field soil loss is held to "T", soil loss on some portion of the slope may reach or exceed 2T, even when the ephemeral gully and other types of erosion that are not estimated by RUSLE are ignored. These higher-than average rates generally occur at the same locations year after year, so erosion on an appreciable part of the field may be occurring at a seriously excessive rate.

With appropriate selection of its factor values, RUSLE will compute the average soil loss for a multicrop system, for a particular crop year in a rotation, or for a particular crop stage period within a crop year. Erosion variables change considerably from storm to storm about their means. But the effects of the random fluctuations such as those associated with annual or storm variability in rainfall-runoff erosivity "R" and the seasonal variability of the cover-management factor "C" tend to average out over extended periods. Because of the unpredictable short-time fluctuations in the levels of influential variables, however, present soil-loss equations are substantially less accurate for the prediction of specific events than for the prediction of longtime averages.

Universal Soil Loss Equation (USLE) has also been used for estimating soil loss from disturbed forested conditions. RUSLE does not address this particular application.

CHAPTER 1

RAINFALL - RUNOFF EROSIVITY FACTOR

RAINFALL-RUNOFF EROSIVITY FACTOR (R)

The rainfall and runoff factor (R) of the Universal Soil Loss Equation (USLE), was derived (Wischmeier 1959, Wischmeier and Smith 1958) from research data from many sources. The data indicate that when factors other than rainfall are held constant, soil losses from cultivated fields are directly proportional to a rainstorm parameter: the total storm energy (E) times the maximim 30-minute intensity (I30).

Rills and sediment deposits observed after an unusually intense storm have sometimes led to the conclusion that significant erosion is associated with only a few severe storms--that significant erosion is solely a function of peak intensities. However, more than 30 years of measurements in many states have shown that this is not the case (Wischmeier 1962). The data show that a rainfall factor used to estimate average annual soil loss must include the cumulative effects of the many moderate-sized storms as well as the effects of the occasional severe ones.

The numerical value used for "R" in USLE and RUSLE must quantify the effect of raindrop impact and must also reflect the amount and rate of runoff likely to be associated with the rain. The erosion index (R) derived by Wischmeier appears to meet these requirements better than any of the many other rainfall parameters and groups of parameters tested against the plot data. The local value of this index may be obtained directly from maps. However, the index does not include the erosive forces of runoff from snowmelt, rain on frozen soil, or irrigation.

In RUSLE, the computation scheme is identical to that used in USLE with a few exceptions.

EI PARAMETER

EI is an abbreviation for energy times intensity, and the term should not be considered simply an energy parameter. Data show that rainfall energy itself is not a good indicator of erosive potential. The storm energy indicates the volume of rainfall and runoff, but a long, slow rain may have the same E value as a shorter rain at much higher intensity.

The relation of soil loss to the EI parameter is asuumed to be linear, and the parameters's individual storm values are directly additive. The sum of the storm EI values for a given period is a numerical measure of the erosive potential of the rainfall within that period. The average annual total of the storm EI values in a particular locality is the rainfall erosion index (R) for that locality.

ISOERODENT MAPS

Local values of the rainfall index may be taken directly from isoerodent maps. The plotted lines on the maps are called isoerodents because they connect points of equal rainfall erosivity. Erosion index values for locations between the lines can be obtained by linear interpolation. Average annual values have been assigned on a county basis and are shown on the R-factor map.

EI DISTRIBUTION USED IN CALCULATIONS OF K-FACTOR AND C-FACTOR

To calculate the seasonal or average annual soil-erodibility factor (K) and the seasonal or average cover-management factor (C), the distribution of EI is needed. In RUSLE the EI distribution (as a percentage of the annual value) is used for twenty-four 15-day periods, corresponding with the 1st and 16th days of the month.